United States Department of the Interior Geological Survey

CONTINUOUS SEISMIC REFLECTION PROFILE RECORDS, SEA 9-78-BS CRUISE, NORTHERN BERING SEA

by

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INTRODUCTION

Seismic reflection data were obtained in the summer of 1978 by the U.S. Geological Survey aboard the R/V SEA SOUNDER along 2500 km of trackline in Norton Sound and northern Bering Sea (Fig. 1). Acoustic survey instruments used included sparker (120 kilojoule), Uniboom (1200 joule), 3.5 kHz subbottom profiler, 7 kHz subbottom profiler, 12 kHz bottom profiler, 200 kHz bottom profiler, and side-scan sonar. All the data acquired on the cruise, including descriptions of vibracores and interpretation of seismic reflection data, can be consulted at U.S. Geological Survey, Rm. B-164, Deer Creek Facility, 345 Middlefield Road, Menlo Park, California.

Microfilm copis of high-resolution seismic and side-scan sonar data are being released for the convenience of others working in the northern Bering Sea, and can be obtained from the National Geophysical and Solar Terrestrial Data Center, NOAA, Boulder, CO 80305. Several projects are currently underway using these data and, to avoid duplication of effort, we ask potential users to check with us before starting any major project.

The cruise, designted SEA 9-78-BS, was divided into two legs; each leg had a specific goal. Leg I departed Nome, Alaska on August 30. This leg was devoted to a detailed geophysical, geotechnical and geochemical survey of the gas-charged sediment in Norton Sound; especially a gas seep, located about 40 km south of Nome. Leg II departed Nome on September 14 and terminated at Teller, Alaska on September 25, 1978. The leg consisted of reconnaissance geophysical transects and sampling stations concentrating on sand-wave dynamics and sedimentology in western Norton Basin (Chirikov Basin of northern Bering Sea).

NAVIGATION

Navigation information was obtained by two independent systems. One system utilized an HP21MX computer to integrate a Magnavox MX 702A satellite receiver, Teledyne TDL 601G Loran-C receiver, gyro, and Bendix speed log. This system computed dead reckoning positions every two seconds; data were stored on magnetic tape and a teleprinter. Accurate fixes for leg I were supplemented by miniranger navigation in northern Norton Sound.

A Motorola mini-Ranger system obtained fixes every seven and one-half minutes on leg I; fixes were recorded on paper tape in digital form. This system measured the range to two or more shore-based transponders that extended, in a network, from Uncle Sam Mountain to West Penny Mountain offshore for up to 75 miles. On a few occasions the included angle between the transponders was too small to permit obtaining reliable fix information.

Fixes were plotted on the navigational charts at least every fifteen minutes; notations were made at the time of major course and speed changes. Radar and line-of-sight bearings were used to augment the other navigational information. Navigation accuracy ranged from $\pm$ 1 km to $\pm$ 150 m; within the miniranger network, accuracy reached to $\pm$ 50 m.

GEOPHYSICAL EQUIPMENT

Seismic profiling operations aboard R/V SEA SOUNDER were carried out at speeds ranging from 4 through 6 knots. Speeds greater or less than this range caused generation of "ship noise" by the propulsion machinery which produced a significant amount of interference on the records. Record quality was also reduced by the occurence of numerous storms and associated rough seas on both legs of cruise S9-78-BS.

Sparker. A Teledyne SSP (Seismic Section Profiler) was used to obtain 70 km of single channel seismic reflection records in the Norton Sound seep area. Power output was normally 100 kilojoules. The signals were received by a Teledyne 100-element Hydrostreamer and processed through a Teledyne seismic amplifier before being printed off a modified Raytheon PFR (Precision Fathometer Recorder). Frequency pass bands were normally 20-98 Hz, and sweep and fire rates were 4 seconds. The records were annotated at 30-minute intervals with date, time (GMT), line number, water depth, and appropriate instrument settings. Changes in course, speed, or instrumentation were noted when they occurred.

Maximum penetration achieved by the sparker was 1/2 to 1 second. The quality of the records was affected adversely by the shallow water and by the generally flat nature of the bottom and subbottom reflectors. The shallow depth caused the water-bottom multiple to appear at small distances below the initial sea-floor reflection, thus partially obscuring signals from deeper reflectors. The flat subbottom layering produced intra-formational or "peg-leg" multiples, which also obscured or interferred with the primary reflections. In only a few places was an acoustic basement detected; more commonly the reflection amplitudes slowly decreased as the signal was attenuated in the sedimentary section.

Uniboom. Approximately 1860 km of high-resolution records were obtained using a hull-mounted EG & G Uniboom system consisting of four transducer plates. Total power level for this array was 1200 joules. An EG & G model 265 hydrophone streamer (10-element) was used as a receiver. Records were printed on an EPC 4100 recorder after passing through a Krohn-Hite filter. Filter pass band was set from 400-4000 Hz.

Sweep and fire rates were 1/4 second. Record annotations simlar to those for the sparker were made at 15-minute intervals.

The quality of the Uniboom records was most affected by sea state, surficial bottom sediment type, machinery-generated ship noise, and acoustic velocity anomalies. The hydrophone streamer was towed alongside the ship 20-30 cm below the surface. Choppy seas generated air bubbles along the streamer, which were responsible for some of the record noise; this sometimes totally obscured subbottom reflectors. Fifteen to twenty percent of the Uniboom records are of poor quality due to the severe storms encountered on the cruise. Maximum penetration achieved was approximately 100 m, but was typically less than 50 m. Whenever coarse-grained and hard sediment was encountered, penetration was severely reduced; in some instances, such as near the Yukon Delta, the records are very poor. In northern Norton Sound, occurrences of velocity anomalies and loss of record are ubiquitous; these velocity anomalies seem to be related to nearsurface, biogenic-gas-charged sediment.

Bathymetry/Subbottom Profiler. About 2560 km of trackline were collected using a Raytheon 3.5 kHz CESP 11 system. A hull-mounted transducer array consisting of 12 TR-109A units sent and received the signals. Pulse generation and correlation functions were by a CESP 11 (Correlator Echo Sounder Processor), and a PTR-105B (Precision Transmitter Receiver) was used as a tone burst amplifier during pulse transmission. Sweep and fire rates were normally 1/2 second. The records were annotated and depth measurements were taken at 15-minute intervals.

Record clarity and penetration varied over the survey area. This system was less sensitive to ship-generated noise than the Uniboom, but the 3.5 kHz records were more adversely affected by shallow water, hard bottom sediment, and rough sea states which were responsible for the poor quality of 10 percent of the records. Hard bottom sediments reduced penetration and sometimes limited data to a bathymetric profile. Penetration ranged from 0-.20 m.

A combination 7 kHz and 200 kHz Raytheon RTT 1000 system was used to collect 900 km of trackline data. The transducers were mounted on a catamaran that towed very poorly in rough seas, limiting collection of good quality records; 90 percent of the records collected, however, are of fair to good quality. The signal was printed on a modified Raytheon 719B recorder. Sweep rate was equivalent to 1/16 second. The system was particularly useful in detailing nearsurface seismic stratigraphy (top 10 m) to correlate with lithology from vibracorer samples. The 200 kHz has a 10 cm resolution capability in measuring bathymetry. It functioned as a trigger for the 7 kHz to prevent false triggering of the 7 kHz transducer from low frequency noise, which is a problem in shallow water. Record annotations similar to those for the sparker were made at 15-minute intervals.

Bathymetry. A hull-mounted 12 kHz transducer was used to collect 2580 km of trackline data. The signal was printed on an EPC 4100 recorder. Sweep and fire rates were 1/2 second. Record annotations were made every 15 minutes.

Side-scan Sonar. A 105 kHz, EG & G side-scan sonar system was used to record about 1740 km of data. Scales (sweeps) of 50 m and 100 m were used on the recorder, and "fish" altitude above the sea floor was maintained at approximately 10 percent of the scale being used.

The side-scan system was used in shallow water areas of known or suspected bedforms, and possible other erosional or depositional features. When the side-scan was deployed, the sparker system was shut down and the associated arc cables and hydrostreamer were brought aboard to prevent their fouling the side-scan cable. Another problem, possibly responsible for poor to blank records in very shallow water (< 10 m) seems to be related to the tow-fish being caught in the prop wash of the ship where bubbles in the water distorted the acoustic signal and the fish was unable to "fly" horizontally. Nevertheless, usable data were obtained approximately 80 percent of the time. Records were annotated at 15-minute intervals.

ACKNOWLEDGMENTS

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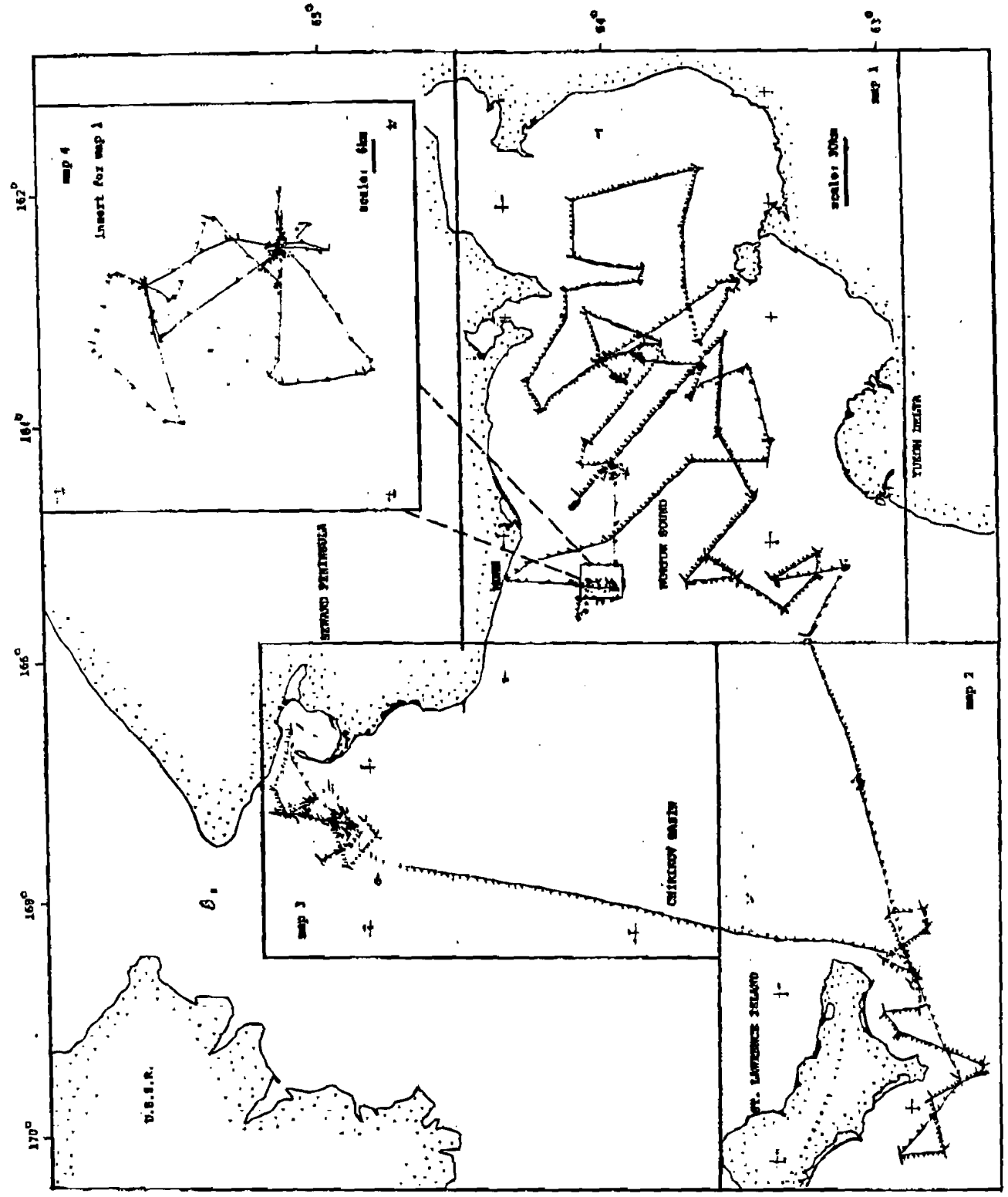

Figure 1. Tracklines in the northern Bering Sea.